

APPLICATION FOR UNITED STATES LETTERS PATENT

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INVENTION:        PRINTING APPARATUS AND METHOD

S P E C I F I C A T I O N

This application claims priority from Japanese Patent Application Nos. 2002-208886 filed July 17, 2002 and 2003-185875 filed June 27, 2003, which are incorporated hereinto by reference.

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## BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

10       The present invention relates to a printing apparatus and method, and more specifically, to a printing apparatus and method for carrying out printing without any margins by inputting a print image having an area larger than the area of a sheet.

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### DESCRIPTION OF THE RELATED ART

      In addition to systems that take a photograph using a silverprint film and then print the photograph, systems  
20       have been used which use a printer to print image data obtained using a digital camera.

      Fig. 1 shows a print system that connects a host computer and a printing apparatus together via an interface. In a printing system composed of a host computer 1302 and  
25       a printer 1303, various data editions are carried out on the basis of various application programs activated on the host computer 1302. The edited data is outputted to a

printer 1303 connected to the host computer 1302 via an interface 1301 (Ethernet (registered trade mark), USB, IEEE1394, or the like), as print data for printing. In this printing system, if the printer 1303 performs an operation of printing print data, a printer driver activated on the host computer 1302 displays dialogs or the like before the application program outputs data so that a user can set print instruction parameters such as the size of a sheet to be printed.

Further, in a printing system composed of a digital camera in place of the host computer, image data obtained by the digital camera is outputted to a printer connected to the digital camera via an interface, as print data for printing. In a printing system composed of a storage medium connected to a printer, image data stored in a storage medium is outputted to the printer as print data for printing. In these printing systems, the user can set the print instruction parameters such as the size of a sheet to be printed, from an operation section of the digital camera or printer.

In general, there is a tendency toward silverprint photographs printed without any margins. Thus, printers are known which can print a photograph without any margins (this printing will hereinafter be referred to as "no-margin printing") in order to print an image like a silverprint photograph. Such a printer outputs a print image of a size  $W_i \times H_i$ , which is slightly larger than the effective area

Wc x Hc of paper for output as shown in Fig. 2. Thus, the output sticks out of the paper to some extent to achieve no-margin printing. Some printers output the sticking-out part to an area in which the paper is not present. Other  
5 printers cut off and remove the sticking-out part of the paper from the remaining part. For example, see Japanese Patent Application Laid-open No. 2002-187261.

On the other hand, there are printers or print systems which can print, in order to obtain an output result larger  
10 than sheets that can be printed by themselves, one page of print data on a plurality of sheets and join them together to obtain a larger output result (this printing will hereinafter be referred to as "poster printing"). For example, see Japanese Patent Application Laid-open No.  
15 2000-25277. For example, the print image of size  $W_i \times H_i$  as shown in Fig. 2 is printed on a plurality of sheets 901 to 908 as shown in Fig. 3.

However, if poster printing is carried out without no-margin printing, margins are present in each sheet as  
20 shown in Fig. 3. Accordingly, in order to join the sheets together to obtain a larger output result, these margins must be cut off.

Further, if poster printing is carried out using a printer that can execute no-margin printing, some parts  
25 of the output stick out of the effective area of sheets. When output data 601 is simply divided and printed on a plurality of sheets 701 to 708 as shown in Fig. 4, some

areas of the data are missing even after the sheets have been joined together as shown in Fig. 5. Therefore, the output result is disadvantageously discontinuous.

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## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a printing apparatus and method that enables no-margin printing to be achieved without the need to cut off margins, while avoiding a discontinuous output result in which the areas between adjacent print images are missing even if poster printing is carried out.

To attain this object, a printing apparatus comprises printing means to which a print image having an area larger than the area of a sheet is inputted to carry out no-margin printing, and output means for dividing, on the basis of an instruction to divide one page of data into a plurality of pieces and print these pieces on respective pages, a print image corresponding to a sheet to be printed so that each piece of the print image corresponding to a piece of the sheet partly overlaps another piece of the print image corresponding to an adjacent piece of the sheet, and then outputting these pieces of the print images.

The data may be divided so that the pieces of the print image corresponding to the adjacent pieces of the sheet overlap a part of the outside or inside of the sheet to be printed. Alternatively, affine transformation may be

executed before the division.

The number of pieces into which the indicated one page of print data is divided is inputted using positive integers for an x and y directions. The division numbers can be  
5 calculated for the x and y directions, respectively, on the basis of an inputted value and the sizes of the sheet in the x and y directions, respectively.

The printing means can carry out printing using an outputted print image in which at least one side of the  
10 sheet has an arbitrary size. The print image can also be outputted by indicating one side of the sheet to the printing means on the basis of the division numbers inputted using the positive integers for the x and y directions, respectively.

15 The above and other objects, effects, features and advantages of the present invention will become more apparent from the following description of embodiments thereof taken in conjunction with the accompanying drawings.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing a conventional printing system in which a host computer and a printing apparatus  
25 are connected together using an interface;

Fig. 2 is a view showing inputted print data;

Fig. 3 is a view showing the result of conventional

poster printing with margins;

Fig. 4 is a view showing the result of conventional poster printing without any margins;

Fig. 5 is a view showing the result of conventional poster printing without any margins followed by joining  
5 together of printed pieces;

Fig. 6 is a block diagram showing a printing apparatus according to a first embodiment of the present invention;

Fig. 7 is a flow chart showing operation of a dividing  
10 section in Fig. 6;

Fig. 8 is a flow chart showing the contents of an enlarging and contracting process at step S203 in Fig. 7;

Figs. 9A to 9F are views showing a dividing process in the enlarging and contracting process;

Fig. 10 is a flow chart showing the contents of dividing  
15 process initialization at step S205 in Fig. 7;

Fig. 11 is a flow chart showing the contents of the dividing process at step S208 in Fig. 7;

Fig. 12 is a view showing the result of poster printing  
20 without any margins carried out by the printing apparatus according to the first embodiment of the present invention;

Fig. 13 is a view showing the result of poster printing without any margins carried out by a printing apparatus according to a fourth embodiment of the present invention;  
25 and

Figs. 14A and 14B is a view showing the result of poster printing without any margins followed by joining together

of printed pieces according to the fourth embodiment.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

5        Embodiments of the present invention will be described below with reference to the drawings.

Fig. 6 shows a printing apparatus according to a first embodiment of the present invention. A printing apparatus 101 is composed of an input buffer 112 and a dividing section 10 113. An input section 111, an instructing section 114, and a printing section 115 are connected to the printing apparatus 101.

With this arrangement, print data outputted by the input section 111 is stored in the input buffer 112. One 15 page of print data from the input buffer is inputted to the dividing section 113. The dividing section 114 then divides the one page of print data in accordance with the division numbers J and K indicated by the instructing section 114. The dividing section 114 then outputs the pieces 20 obtained by the division to the printing section 115 as a plurality of print images.

Here, the division numbers J and K are each a positive integer indicative of the number of pieces into which print data is divided in an x or y direction of the print data. 25 The plurality of print images outputted to the printing section 115 are printed on the respective sheets.

Fig. 7 is a flow chart of operations of the dividing



section in Fig. 6. At step S201, the instructing section 114 inputs the numbers J and K indicating the number of sheets on which the respective images are printed. At step S202, one page of print data from the input buffer 112 is  
5 inputted to the dividing section 113. At step S203, the inputted print data is subjected to an enlarging and contracting process.

At step S204, counters j and k are initialized to zeros. At step S205, initialization is executed for a dividing  
10 process. At step S206, if  $k < K$ , the procedure proceeds to step S207. Then at step S207, if  $j < J$ , a dividing process is executed at step S208. Subsequently, at step S209, j is incremented. Then the procedure returns to step S207.

At step S207, if j is not smaller than J, then at step  
15 S210, k is incremented and j is initialized to zero. The procedure then returns to step S206. If k is not smaller than K at step S206, the process is ended.

Operations of the dividing section 113 correspond to subjecting one page of the print data inputted by the input  
20 buffer 112, to affine transformation, i.e. synthesis of linear transformation and parallel movement, and then outputting a rectangular area contained in the transformed print data to the printing section 115.

Fig. 8 shows the contents of the enlarging and  
25 contracting process at step S203 in Fig. 7. At step S202, one page of print data 801 from the input buffer 112, which data is shown in Fig. 9A, is enlarged or contracted to become

transformed print data 802, shown in Fig. 9C. The enlarging and contracting process is executed using the transformation matrix shown at step S301, on the basis of the size of a sheet 810 to which the data is to be outputted, the sheet being shown in Fig. 9B. [x<sub>in</sub>, y<sub>in</sub>] are coordinates of the print data 801 before the enlarging and contracting process. [x, y] are coordinates of the transformed print data 802 after the enlarging and contracting process.

Here, W<sub>i</sub> and H<sub>i</sub> denote the sizes of the inputted print data 801 in the x and y directions, respectively. W<sub>c</sub> and H<sub>c</sub> denote the sizes of print data printed in an effective area in the sheet in the x and y directions, respectively. W<sub>o</sub> and H<sub>o</sub> denote the sizes of the sheet 810 to which the print data is to be printed in the x and y directions, respectively. The transformation matrix increases the size of the print data in the x direction by a factor of  $(W_o/W_c) \cdot J$ , while increasing the size of the print data in the y direction by a factor of  $(H_o/H_c) \cdot K$ .

Fig. 10 shows the contents of the dividing process initialization at step 205 in Fig. 7. At step S401, constants P and Q used to represent areas in the print data outputted to the respective sheets are initialized as  $P \leftarrow (W_i/W_c - 1)(J - 1)W_o/2$  and  $Q \leftarrow (H_i/H_c - 1)(K - 1)H_o/2$ .

Fig. 11 shows the contents of the dividing process at step S208 in Fig. 7. At step S501, p<sub>1</sub> and p<sub>2</sub> denote coordinates in the x direction of the data 803, and q<sub>1</sub> and q<sub>2</sub> denote coordinates in the y direction of the data 803,

as shown in Fig. 9D. The following substitutions are possible:  $p1 \leftarrow P + jxWo$ ,  $p2 \leftarrow p1 + (Wi/Wc)Wo$ ,  $q1 \leftarrow Q + kxHo$ , and  $q2 \leftarrow q1 + (Hi/Hc)Ho$ .

Then at step S502, rectangular areas from the data  
5 803 each of which has points  $[p1, q1]$  and  $[p2, q2]$  as diagonal lines are outputted to the printing section 115. Thus, as shown in Fig. 9E, the rectangular area 804 is outputted to the sheet 811 to be printed, and the rectangular area 805 is outputted to the sheet 820 to be printed. In this  
10 dividing process, each of the plurality of rectangular areas obtained by the division overlaps its adjacent rectangular area by the distance  $(Wi/Wc-1)Wo$  in the x direction and by the distance  $(Hi/Hc-1)Ho$  in the y direction. For example, that part of the rectangular area 804 which corresponds  
15 to the distance  $(Hi/Hc-1)Ho$  from its lower end is also outputted at the upper end of a rectangular area 805.

This is because those parts of the rectangular area 804 which correspond to the distance  $(Wi/Wc-1)Wo/2$  from the respective ends in the x direction and to the distance  
20  $(Hi/Hc-1)Ho/2$  from the respective ends in the y direction are outputted to the outside of the effective area of the sheet and are not contained in the output result. If, for example,  $J=2$  and  $K=4$ , such a dividing process enables no-margin printing to be achieved over eight sheets 812  
25 to 819 as shown in Fig. 9F, while avoiding a discontinuous output result in which the areas between adjacent print images are missing.

The first embodiment is particularly effective if the printer can carry out mechanically accurate no-margin printing. The first embodiment does not require margins of paper left for applying paste but enables poster printing  
5 to be accomplished by arranging sheets without any gaps rather than pasting each sheet to its adjacent one.

Now, description will be given of a second embodiment of the present invention. The second embodiment differs from the above described first embodiment in the contents  
10 of inputted instructions from the instructing section 114 and in the contents of a dividing process executed by the dividing section 113.

The instructing section 114 shown in Fig. 6 inputs only the number J of sheets on which the respective images  
15 are to be printed. In this case, J denotes a positive integral representing the number of pieces into which the print data is divided in the x direction.  $J \cdot H_o \cdot W_c / (H_c \cdot W_o)$  is substituted for the number K of pieces into which the print data is divided in the y direction. This enables  
20 poster printing with the ratio of the size of the print data 801 in the x direction to its size in the y direction maintained at  $H_i$  to  $W_i$ .

However, if the value of K is not a positive integer, if  $K-1=k < K$  in the flow chart shown in Fig. 7, then for the  
25 rectangular area outputted to the printing section 115 at step S208, no-margin printing may not be achieved on one side of the sheet but a space may be contained within the

effective area.

Now, description will be given of a third embodiment of the present invention. The printing section 115 in the third embodiment is different from the one of the printing apparatus in the above described first embodiment.

The printing section 115 shown in Fig. 6 is a device that prints a sheet on a roll. The printing section 115 allows the size  $H_o$  of a sheet in the y direction to be arbitrarily set. The instructing section 114 inputs the numbers J and K indicating the number of sheets on which the respective images are to be printed. Here, the numbers J and K are each a positive integer indicative of the number of pieces into which print data is divided in the x or y direction. The dividing section 113 sets the size  $H_o$  of the sheet in the y direction in the printing section 115 as  $H_c \cdot W_o \cdot J / (W_c \cdot K)$ .

This enables poster printing with the ratio of the size of the print data 801 in the x direction to its size in the y direction maintained at  $H_i$  to  $W_i$ .

Now, description will be given of a fourth embodiment of the present invention. The fourth embodiment differs from the above described first embodiment in the operation of the dividing section 113 of the printing apparatus.

The output result from the printing apparatus in the first embodiment is such that when the sheets 812 to 819 are joined together, the original images are properly connected together via the ends of the sheets as shown in

Fig. 12. The output result from the printing apparatus in the forth embodiment is such that when the sheets 1201 to 1208 are overlapped together, the original images are properly connected together via the ends of the sheets as shown in Fig. 13. In Fig. 12, the sheets 812 to 819 of the same size  $W_o \times H_o$  are arranged in both x and y directions without any overlapping parts. In Fig. 13, sheets of the same size  $W_p \times H_p$  are arranged in the order of 1202, 1203, 1206, 1207, 1204, 1205, 1208, and 1201 in a direction approaching the reader so that their ends overlap one another.

The dividing section 113 shown in Fig. 6 uses as virtual sheet sizes the sizes  $W_o$  and  $H_o$  of a sheet in the x and y directions, respectively, which are used in the process shown in Figs. 8, 10, and 11. The dividing section 113 sets the sizes  $W_o$  and  $H_o$  to be smaller than the sizes  $W_p$  and  $H_p$  of a sheet in the x and y direction, respectively, which are actually used in printing. The ranges of the values of  $W_p$  and  $H_p$  are  $W_i/W_c = W_p/W_o = 1$  and  $H_i/H_c = H_p/H_o = 1$ .

For example, as shown in Fig. 14A, that part of the sheet 1202 which corresponds to the distance  $(H_p - H_o)$  from its lower end is also outputted at the upper end of the sheet 1204. By laying the sheet 1202 on top of the sheet 1204 so that the above part overlaps the upper end of the sheet 1204 as shown in Fig. 14B, the output is such that the original images are properly connected together.

Thus, when no-margin printing is carried out and if

any area outside the effective area of the sheet is printed owing to the mechanical accuracy of the printing section or the like, all the original image areas can be outputted by laying the end of each sheet on top of the end of the  
5 corresponding sheet.

Now, description will be given of a fifth embodiment of the present invention. The fifth embodiment differs from the above described first embodiment in that a print image is divided by a host computer connected to the printing  
10 apparatus.

A printer driver activated by a host computer 1302, shown in Fig. 1, displays a dialog to prompt the user to input the division numbers J and K as print instruction parameters. The process shown in Figs. 7, 8, 10, and 11  
15 is executed on image data edited by an application program. In this manner, as shown in Fig. 9F, print data is divided into pieces corresponding to the sheets 812 to 819 to which the data is to be outputted, and is then outputted to a printing apparatus 1303 via an interface 1301. The dividing  
20 process can be executed by the application program in place of the printer driver. In this case, the application program can output print data to the printing apparatus without using the printer driver.

Even with a system that cannot buffer, in the printing  
25 apparatus, a print image for one sheet transmitted by the host computer, a poster printing function can be used to carry out no-margin printing while avoiding a discontinuous

output result in which the areas between adjacent print images are missing.

The present invention has been described in detail with respect to preferred embodiments, and it will now be  
5 apparent from the foregoing to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspect, and it is the intention, therefore, in the apparent claims to cover all such changes and modifications as fall within the true spirit  
10 of the invention.